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The timing of trademark application in innovation processes

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ABSTRACT

An emerging stream of literature is studying the extent to which trademarks can be used to measure innovation. The picture of the usefulness of trademarks for innovation studies, however, is far from complete. Starting with cues from the patent literature, this paper studies the relationship between the timing of trademark applications and innovation. The trademark literature provides competing predictions on whether companies apply for trademarks early or late in the innovation process. Using a large sample of trademarks referring to innovation, we undertake a first empirical test of these predictions. Our findings suggest that in many instances reality is not as clear cut as the predictions suggest. However, when trademark data is combined with data on firm age, sector and size it is possible to predict whether a trademark refers to early or late-stage innovation.

1. Introduction

An emerging field of empirical literature is concerned with how trademark statistics might potentially measure innovation (Allegrezza and Guarda-Rauchs, 1999; Greenhalgh and Rogers, 2012; Schautschick and Greenhalgh, 2016; Schmoch, 2003). Because many trademarks are filed to signal the introduction of new products or services (Mendonça et al., 2004) and because they are usually assumed to be filed close to the market introduction of new products (Hipp and Grupp, 2005), they may measure downstream, late-stage innovation that is not adequately captured by patent statistics (Candelin-Palmqvist et al., 2012; Flikkema et al., 2014). Other authors have argued that trademarks may be filed earlier in the innovation process and may therefore indicate early stage innovation as well (Lemper, 2012; and Zhou et al., 2016). This paper investigates whether organizations file trademark applications early or late in the innovation process, examining factors influencing the timing of trademark applications.

The current literature provides competing predictions about the timing of trademark applications. However, the empirical evidence is scarce and the results mixed. To enhance our understanding, this paper considers the timing of trademark application during the innovation process. We explore whether trademark application timing can be explained by two factors, around which there are competing views in the literature: the joint use of patents and trademarks, and the micro-level innovation mode. This approach will help us gain insight into whether trademarks can be used to measure innovation at different stages of the

innovation process. In Section 2, we review the literature about the timing of patent applications to determine whether reasons for early or late filing identified in relation to patents also apply to trademarks. This review provides the background for Section 3, in which we consider the competing explanations of why companies apply for trademarks early or late in the innovation process. In Section 4, we present the research design and the data collection methods. Section 5 is dedicated to the results, while the final section includes the discussion and implications for future research.

2. The timing of patent and trademark applications

Firms benefit from various intellectual property rights (IPRs) to appropriate returns from innovation (Davis, 2006; Teece, 1986). The actual timing of the engagement of different IPRs requires great precision. Empirical studies into the timing of such applications are limited and most focus on the timing of patenting in particular (Harhoff and Reitzig, 2001; Hipp and Grupp, 2005; Johnson and Popp, 2001). The reason for early patenting is obvious and embedded in the patent system: the first to file a patent which is ultimately granted, gains the monopoly right.

Because of their nature and relatively short handling times at IPR offices, the literature assumes that trademarks are registered close to the market introduction of a new product or service (Hipp and Grupp, 2005; Rujas, 1999). Studying a sample of SMEs, Flikkema et al. (2014) show that this is largely correct for about 60% of the trademarks

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Table 1
Competing arguments for early versus late application for trademarks.

Antecedents of the timing of trademark application	Arguments for <i>early</i> trademark application	Arguments for <i>late</i> trademark application
1.1. Does the <i>combination with patents</i> affect the timing of the trademark application?	Trademark application enables the attraction of venture capital and thus will often be filed earlier than patents.	Trademark application predominantly serves to protect brand names for new products and services, therefore it suffices to apply for a trademark just before the launch of a new product or service. Protection of complementary assets is not needed in upstream stages of the innovation process. Combination with patents reduces the need for early trademark application as a mechanism for protecting IP.
2. Does the <i>innovation mode</i> affect the timing of the trademark application?	<p>A. <i>Length of development cycle</i>:</p> <ul style="list-style-type: none"> i. Product innovation, new-to-the-world innovation or B2B innovation imply longer duration of development cycles and therefore higher probability of trademark application in the early stages to foster a market orientation. ii. For most service innovations, opportunities for patenting or benefiting from other IPRs are limited and the priority principle also applies to trademarks, which results in earlier trademark application. <p>B. <i>Start-up versus incumbent firms</i>:</p> <p>Trademarks mark the start of an innovative start-up, entrepreneurs attempt to benefit from trademarks to attract venture capital in upstream stages of the innovation process and, finally, trademarks are possibly used in upstream stages of the innovation process as a substitute for patents.</p>	<p>A. <i>Length of development cycle</i>:</p> <ul style="list-style-type: none"> i. Product innovation, new-to-the-world or B2B innovation imply late trademark application for reasons of very long development cycles, which approximate or exceed the period of the use in commerce requirement (five years). ii. Service innovation, B2C and incremental innovation have shorter development cycles and new services emerge on the service job. This leads to late trademark application. <p>B. <i>Start-up versus incumbent firms</i>:</p> <p>Start-ups prefer secrecy, especially for more radical innovation, because they do not have deep pockets to counter the violation of IPRs as do mature firms.</p>

referring to innovation. The remainder of the trademarks are either registered during early innovation stages or, as occurs in a substantial number of cases, are filed after the market introduction of new products and services. As the literature only partially studies the reasons behind early or late trademark applications, we first review whether the patent literature provides arguments that may apply to trademarks as well.

The main reason for the early application for patents is that they are granted based on a priority principle. This principle may lead companies to apply for a patent as soon as possible in a patent race (Denicolo, 1996). Studies have, however, highlighted at least three reasons why inventors would delay their patent application. The first is to postpone information disclosure. Information disclosure is a prerequisite for patent application, but may also provide competitors with useful information facilitating imitation (Leiponen and Byma, 2009). Second, by postponing patent application, the length of patent protection once a product has ultimately been introduced into the market can be extended in order to better recoup development costs. The third reason is to cut the costs of patent taxes. Patent protection in multiple countries can become very costly (Berrier, 1995; Lanjouw et al., 1998). Firms will therefore delay patent application until they are certain that they will recover all of the costs involved in patent application and renewal. Nevertheless, studies also emphasize that inventors may run the risk of waiting too long. Choosing the right time to file is therefore essential for patent applicants.

Early registration of trademarks may occur for the same reasons as early registration of patents. Companies may want to apply for trademarks early because, like patents, trademarks are based on priority. This implies that the first to apply for a trademark for certain goods or services in a particular country or region, acquires the legal right to prevent others from using similar trademarks in the same markets.

The three reasons mentioned above for postponing patent application, however, do not apply to trademarks. First, information disclosure only partly applies to trademarks, since a trademark only reveals some characteristics of a product and/or the firm's marketing strategy. Unlike patents, when applying for a trademark, the applicant only has to disclose a minimal amount of information about the goods or services covered by the trademark. Second, unlike patents, a trademark can be prolonged indefinitely. This is the reason why trademarks are popular in the pharmaceutical sector (Chudnovsky, 1983), fostering customer loyalty beyond patent expiration. Finally, the costs of maintaining a trademark are much lower than the costs of patent protection. Postponing a trademark application will therefore not lead to considerable cost savings.

We conclude that the arguments for the timing of patent applications shed some light on the mechanisms behind the timing of early trademark registration. The literature also shows that trademarks are used in very diverse circumstances, indicating that trademark-specific arguments may explain early or late trademark applications. In Section 3, we explore the consequences of combining patents and trademarks and differences between innovation modes.

3. Competing arguments for early or late trademark application

Table 1 summarizes competing arguments for early or late trademark application. It remains an open empirical question which of these are valid.

3.1. Joint use of trademark and patents

In the previous section, we separately reviewed motives for early or late engagement in patent or trademark applications for innovation purposes. However, in many cases, firms apply for both patents and trademarks for reasons of complementarity (Llerena and Millot, 2013; Thomä and Bizer, 2013; Zhou et al., 2016). Trademarks may prolong the time during which an innovation can be exploited in the market (Thomä and Bizer, 2013) or protect assets that are complementary to

technological innovation. Block et al. (2015) and Zhou et al. (2016) emphasize the role of trademarks in attracting venture capital. Zhou et al. (2016) found that start-ups applying for both patents and trademarks receive higher amounts of venture capital funding than do start-ups that apply for only one. This suggests the importance of early stage trademark application.

However, there are also reasons why trademarks may be applied for later in the innovation process in cases where they are applied for in tandem with patents. The IPR literature (Hipp and Grupp, 2005) suggests that patents concern early stage innovation, whereas trademarks will be filed later, just before market entry. Trademarks fulfil a specific role in the commercialization stage, by flagging the new product introduction. They seem to protect brand equity rather than intellectual property. This specific role leads companies to apply for trademarks at a later stage. In addition, in the case of the combined use of patents and trademarks, trademarks may be applied for later, since the patent provides better protection than a trademark against the exploitation of new technologies by imitators (Llerena and Millot, 2013). The practical need for a trademark is thus less pressing.

3.2. Innovation mode

The literature also points to the micro-level innovation mode as an antecedent of the timing of trademark applications. The literature points to clear differences in innovation processes for Business-to-Business (B2B) and Business-to-Consumer (B2C) products versus services, incremental versus radical types of innovation, and for start-ups versus established firms. Again, theory supports competing arguments regarding whether these modes are associated with early or late application.

3.2.1. Length of development cycle

The literature suggests that development cycle characteristics may have an impact on early or late application for trademarks. Innovations with absolutely and relatively long development cycles, such as those in product innovation, new-to-the-world innovation and B2B innovation, have longer R&D phases than service innovations, incremental innovations and B2C innovations (Griffin, 1997, 2002). For the former innovation types, this increases the probability of companies applying in an early phase, because this phase may account for a large part of the entire process. Moreover, to improve new product performance, firms tend to integrate R&D and marketing processes, especially in the case of long and costly new product development processes (Griffin and Hauser, 1996), as in the pharmaceutical sector (Becker and Lillemark, 2006). Notwithstanding, the trademark law requires them to be used within five years of application. This may imply that the longer the development cycle, the later an organization will apply for a trademark, thus limiting the risk of an innovation not being marketed within that five-year period and the trademark lost.

In relation to service innovation, the literature argues that as trademark law is based on the principle of priority, early trademark application is essential to obtain the exclusive rights connected to the trademark (Lemper, 2012). The means of protection available in the case of service innovation is often limited to trademark application, while in the case of product and process innovation, more than one type of IPR is often available, such as patents or design rights. The development of, or control over, co-specialized assets, such as secrecy and complexity of design, are also more frequently relevant in the case of product and process innovation. Service prerequisites are easier to reconstruct, as opposed to the reverse engineering of complex products. In the case of service innovation, keeping things quiet or restricting knowledge flows is not always possible (Hurmelinna-Laukkanen and Ritala, 2010), and interdependence with customers (Xue et al., 2005), which often applies to service innovation, makes relying on secrecy problematic (Hannah, 2005; Martin and Salomon, 2003).

In many cases, the delivery process is quite transparent. This is

supported by empirical evidence gathered by Gallié and Legros (2012), who found the use of secrecy and complexity of design to be very limited in service sectors such as real estate and customer services compared to others. Therefore, trademarks are often the only way to protect a new service. Being first, and thus opting for early trademark application, may therefore be essential.

The arguments for the case of the later application for trademarks by service firms centre around the idea that new service development processes differ markedly from product innovation processes (Alam and Perry, 2002; Booz, Allen and Hamilton, 1982; De Brentani, 1989; De Brentani and Cooper, 1992; Sundbo, 1997), although intra-sector heterogeneity is high in the service industry (Hughes and Wood, 2000). Because of its intangible character, service innovation is difficult to capture and therefore its research & development process is also more challenging to describe (Sundbo, 1997; Drejer, 2004; Flikkema et al., 2007).

Alam and Perry (2002) and Sundbo (1997) state that in most cases the generation of new ideas for services is not formalized. It is a creative and fortuitous process, mostly generated from the bottom-up and often in response to specific client needs. Therefore, very often service innovation is not or only partly planned (Flikkema et al., 2007), but triggered by external influences, for example supplier dominance (Pavitt, 1984). Because of the interactive nature of services, customer orientation and interaction is very important in the processing of these new ideas.

Another reason why service innovation may lead to later trademark application is the short duration of service innovation processes. Different stages, which are separated in the product development process, may take place concurrently in the case of service innovation (Alam and Perry, 2002; Sundbo, 1997) or might be bypassed as a consequence of supplier-dominated innovation. Upstream innovation stages may therefore be particularly difficult to discern. A service innovation may often only be recognized as such after proven success in the market.

In summary, the service innovation process is less linear than the product innovation process. Moreover, development cycles are relatively shorter in service innovation (Griffin, 2002) because stages take place concurrently or may be bypassed. IPR protection may occur only when the innovation is already implemented, that is, delivered.

3.2.2. Start-ups versus incumbents

In relation to IPR, the literature clearly finds that large established firms deal differently with their intellectual property compared to start-ups (Mann and Sager, 2007). Research on the use of IPRs by (innovative) start-ups provides three main reasons why they may use trademarks. First, start-ups use trademarks to attract investors. Research by Block et al. (2014) and Zhou et al. (2016) on the use of trademarks by high-tech start-up firms indicates that early trademark application may enhance their value potential for venture capitalists.

Second, start-ups embody innovation, with trade names often filed to mark the start of a new, innovative company. Schneider and Veugelers (2013) found that innovative start-ups that are less than 10 years old, have less than 250 employees and spend at least 10% of their revenues on R&D use significantly more trademarks than other innovators. Finally, as start-ups have limited resources, trademarks may also function as substitutes for patents, especially in consumer-oriented markets (De Vries et al., 2017). This might entail applying for trademarks relatively early in the innovation process. There is, however, also evidence that start-ups may prefer to delay trademark application. Although Schneider and Veugelers (2013) found that innovative start-ups use more trademarks than other innovators, they also found that innovative start-ups are more likely to use secrecy, which might entail the delay of IPR application, especially for radical innovation.

4. Survey and variables

The empirical evidence in this paper is based on data collected from a survey of trademark applicants. This survey considers individual trademarks as the units of observation, thereby providing case-level evidence on the relationship between trademarks and innovation. In cooperation with both the BOIP (Benelux Bureau for Intellectual Property) and the EUIPO (European Intellectual Property Office, formerly OHIM), an online questionnaire was distributed among applicants who applied for at least one trademark at one of the offices in 2009, and which had been granted within two years. Novagraaf, a large international IPR agency based in the Netherlands, helped in recovering contact information for large-firm applicants, who typically only report the IPR agency contact in their trademark application.

The survey set out several questions, varying from respondent characteristics, such as firm size and sector, market orientation, branding strategy and maturity of the IPR strategy, to aspects of the trademark registration process, such as motivation, involvement of trademark attorneys, timing of the trademark application and the bundling of trademarks with other IPRs. The initial sample contained responses from 1015 trademark applicants, which also included trademarks that did not refer to an innovation. After removal of these, we had a sample of 677 applicants who had applied for a Benelux Trademark ($n = 288$) or a Community Trademark ($n = 389$) in 2009, and who declared that the trademark referred to something new: a new or improved product, service, process, a significant change in the design, packaging, promotion or pricing of existing products or services, or a significant change in the advertising of existing products or services.

In addition to applicant and trademark characteristics, the survey included questions on the motives of the applicant, the trademark reference to innovation and the use of other IPRs (both formal and informal). If the trademark referred to an innovation, the applicants were asked about the stage of the innovation process in which the trademark

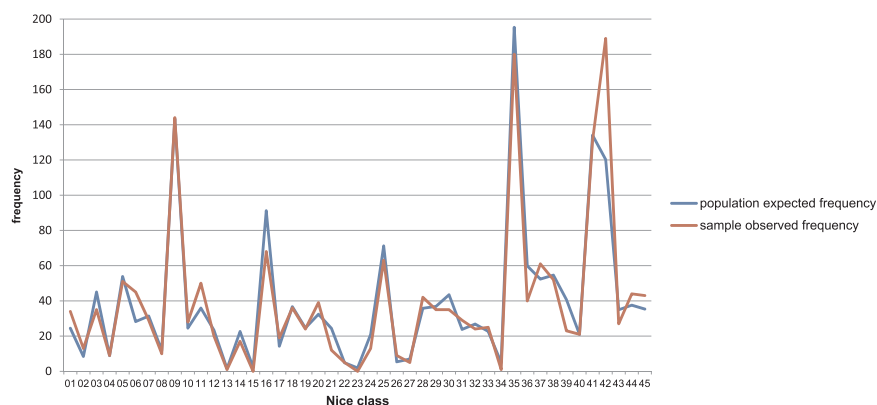


Fig. 1. Sample and population distribution over the Nice classes.

Table 2
Sample descriptives.

Variable	Categories	n (original sample)	Original sample share	Operationalization	value	n (analysis)	Final analysis sample share
Dependent							
1. Timing (7 phases)	Idea phase	75	11%		1	63	11%
	Research phase	42	6%		1	36	6%
	Development phase	150	22%		1	130	22%
	Test phase	46	7%		1	38	7%
	Marketing phase	142	21%		1	130	22%
	Introduction phase	124	18%		1	104	18%
	Commercial phase	98	15%		1	84	14%
Patents							
2. Combination with patent(s)	Yes	123	18%	Patent dummy	1	110	19%
	No	554	82%		0	475	81%
Innovation mode							
Length of development cycle							
3. Reference to product innov.	Applicable	371	55%	Product innovation reference dummy	1	326	56%
	Not applicable	306	45%		0	259	44%
4. Reference to service innov.	Applicable	196	29%	Services innov. reference dummy.	1	160	27%
	Not applicable	481	71%		0	425	73%
5. New-to-the-world innov.	Yes	89	13%	New-to-the-world dummy	1	81	14%
	No	588	87%		0	504	86%
6. B2B	B2B	463	68%	B2B dummy	1	446	76%
	B2C	301	44%		0	139	24%
	Other	57	8%		0	0	0%
Start-ups versus incumbents							
7. Firm maturity	Future start-ups	26	4%	Start-up dummy	1	26	4%
	Start-ups	246	36%		1	246	42%
	Mature firms	313	46%		0	313	54%
	Not applicable	92	14%		0	0	0%
Controls							
8. Firm size	1 A one-man business	128	19%		0	116	19%
	2–4	154	23%		0	140	24%
	5–9	92	14%		0	74	13%
	10–49	125	18%	Medium firm size dummy	1	111	19%
	50–249	66	10%		1	52	9%
9.	250–499	14	2%	Large firm size dummy	1	11	2%
	≥ 500	77	11%		1	65	11%
	Not applicable	21	3%		0	16	3%
10. Firm sector	SD	115	17%	SD dummy	1	108	19%
11.	SI	90	13%	SI dummy	1	82	14%
12.	SS	32	5%	SS dummy	1	29	5%
13.	SB	33	5%	SB dummy	1	32	6%
14.	SDS	84	12%	SDS dummy	1	81	14%
15.	PN	52	8%	PN dummy	1	47	8%
16.	IN	61	9%	IN dummy	1	58	10%
17.	KIBS	70	10%	KIBS dummy	1	69	12%
18.	Non market services	29	4%	Non-market services dummy	1	27	5%
	Other	211	31%		0	52	9%
Trademark-related controls							
19. TM ref goods and services	Yes	244	36%	TM ref goods and services dummy	1	212	36%
	No	433	64%		0	373	64%
20. Trademark experience	First-time applicants	289	43%	Trademark experience dummy	0	256	44%
	Frequent users	388	57%		1	329	56%
21. Use of IPR agency	Yes	155	23%	Use of IPR agency dummy	1	130	22%
	No	522	77%		0	455	78%

application was filed, according to the seven stages defined in Cooper's (1983) new product development (NPD) process.

Of 677 respondents, 585 answered all of the questions required to be used in our final analysis. Cooper's NPD model was also used for trademark applicants referring to service innovation. An advantage of using the same innovation process model for trademarks relating to new products and services is that differences in the timing of a trademark application can be better identified and thus reveal differences in the importance of various stages in the product versus the service innovation processes.

To check whether the responses were a good representation of the whole population, we compared the distribution of the Nice class trademarks in our sample with the whole population. Fig. 1 shows the trademark volumes in all Nice classes based on the EUIPO and BOIP databases (population expected frequency) and the sample dataset (sample observed frequency). Fig. 1 shows a similar pattern for the observed sample frequencies and the expected population frequencies. However, a Chi-square test revealed a small but significant difference ($\chi^2(45) = 121.90, p < .001$), due to the underrepresentation of Nice class 16 (paper, cardboard and goods made from these materials), class

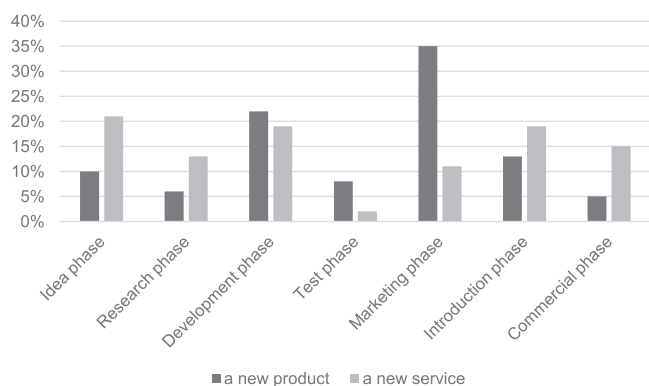


Fig. 2. The timing of trademark applications for product and service innovation.

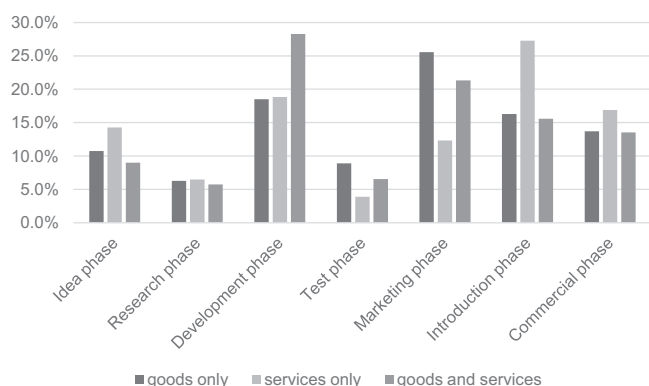


Fig. 3. Timing of trademark application versus Nice class reference.

21 (household or kitchen utensils), class 36 (insurance) and class 39 (transport), and the overrepresentation of class 6 (common metals and their alloys, ores) and class 42 (scientific and technological services).

In addition to applicant sector information and information on the Nice classes of the trademarks in our sample, we had other useful information on the innovation itself. Ideally, we would also like to account for different appropriability regimes that firms might face. Since we did not have survey data at the firm-level on this aspect, we created a proxy for the strength of the appropriability regime by using an innovation-based taxonomy which took into account sectoral differences in appropriability regimes in our robustness checks. Castellacci (2008) integrated innovation-based taxonomies proposed by Pavitt (1984) for sectors in manufacturing and those by Miozzo and Soete (2001) for services, both accounting for specific appropriability strategies used by firms in each group of sectors. In this combined taxonomy, firms are classified into eight groups of sectors: supplier-dominated manufacturing (SD), scale-intensive manufacturing (SI), specialized suppliers

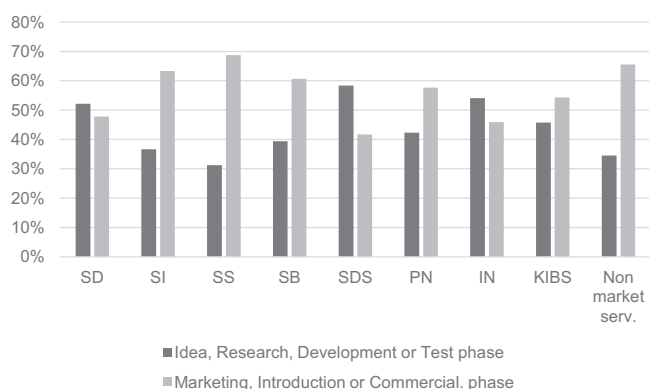


Fig. 4. Timing of trademark application versus firm sector.

(SS), science-based manufacturing (SB), supplier-dominated services (SDS), scale-intensive physical networks (PN), information networks (IN) and knowledge-intensive business services (KIBS). There is an additional category of non-market services, which include non-commercial public and social services. We could assign all trademark applicants in our sample to one of the groups of sectors by relying on the concordance with the 2-digit level NACE industrial classification in Castaldi (2009), also used in Flikkema et al. (2014).

Our dependent variable was an ordinal variable corresponding to the seven stages of Cooper's NPD model. Therefore, the application of an ordinal regression model was a logical choice. Ordinal regression models are obtained by modifying the binary regression model to include the ordinal nature of a dependent variable (Norušis, 2012). As a robustness check, we also used a binary regression analysis where the dependent variable was *late* trademark application (trademark application at the marketing stage or later) as opposed to *early* trademark application (trademark application earlier than the marketing stage).

Our independent variables were measured with dummies and categorical variables. A dummy was used to consider the joint use of one or more patents to protect the innovation referred to by the trademark. To test the influence of the differences in innovation mode, we studied three characteristics that are expected to influence the length of development cycles (Griffin, 2002): product versus service innovation; the reference to B2B products/services; and whether the trademark refers to innovation which is new to the world. Dummies were defined for these characteristics. In the case of the dummies representing product and service innovation, the reference category included all other forms of innovation mentioned by the survey question.

A dummy was also introduced to represent the maturity of the firm whose trademark refers to innovation. This dummy was 1, if the respondent indicated it was a start-up or a future start-up. To study the influence of sectoral differences, we used dummies as control variables representing the innovation-based taxonomy defined earlier in this section. Other control variables used were: firm size, whether the trademark referred to both goods and services, whether the applicant had filed a trademark before, and whether the application was done with the help of an attorney.

5. Results

5.1. Descriptives

Table 2 presents the descriptive statistics for the variables used in this study and the dummies created.

5.1.1. Product versus service innovation

In our sample, about 45% of all trademarks were filed before the marketing stage. Clear differences are visible in the timing of trademark application in the case of service innovation as compared to product innovation, as can be seen in Fig. 2.

Trademarks referring to new services were registered more frequently in the first two stages of the innovation process or during the last stages (introduction and commercialization stages) compared to product innovations, where trademarks dominate the middle stages of the innovation process. The largest difference was found in the marketing stage: 35% of trademarks referring to product innovation were filed in this stage as compared to 11% for service innovation.

Fig. 3 shows the differences in the timing of trademark applications between the trademarks referring only to goods, those only to services, and those referring to both goods and services. More than 25% of the trademarks whose Nice classes only refer to goods were filed during the marketing stage. In contrast, for Nice classes only referring to services, more than 25% were filed in the introduction stage, with less than 15% filed during the marketing stage.

Trademarks applied for by organizations that offer a combination of goods and services tend to be filed earlier, especially during the

Table 3
Correlation analysis.

Dependent	1.	2.	3.	4.	5.	6.	7.	8.
Patent								
1. Timing of TM application (7 phases)								
2. Combination with patent (s)	-.078*							
3. Product innovation	.041	.251**						
4. Service innovation	.045	.000	-.336**					
5. New-to-the-world innovation	.165	.000	.081	.002				
6. B2B	.001	.000	.035	.055				
7. Start-up	.493	.464	.471	.175	-.013			
8. Medium firm size	.000	.007	-.080	.174*	.222*	-.019		
9. Large firm size	.080*	.037	.081	.000	.000	.645		
10. Supplier dominated manuf. (SD)	.036	.342	.034	.012	.073	.087*	-.297**	
11. Scale intensive manuf. (SI)	.100**	.129**	.088*	-.070	-.115*	.029	.000	-.247**
12. Specialized suppliers (SS)	.009	.001	.022	.068	.003	.894	.000	.000
13. Science-based manuf. (SB)	-.044	.042	.213*	-.219*	.068	.027	-.055	-.013
14. Supplier-dominated serv. (SDS)	.253	.276	.000	.000	.075	.495	.185	.743
15. Physical networks (PN)	.076*	.064	.172*	-.154*	-.036	.029	.149**	.054
16. Information networks (IN)	.049	.098	.000	.000	.344	.465	.000	.159
17. Knowledge int. bus. serv. (KIBS)	.064	.220**	.090*	.081*	.078*	.035	-.102*	-.016
18. Non-market serv.	.098	.000	.019	.036	.042	.381	.013	.680
19. TM refers to both goods + services	.011	.071	.123*	-.084*	.013	-.044	-.013	.041
20. Previous trademark experience	.776	.064	.001	.029	.727	.278	.749	.287
21. Use of IPR agency	-.101**	-.096*	-.135*	.115*	-.051	.172*	-.097*	-.097*
	.008	.012	.000	.003	.719	.203	.000	.012
	.055	-.064	-.039	-.111*	-.079*	.002	-.061	.041
	.155	.096	.311	.004	.039	.956	.139	.286
	-.074	-.068	-.139*	.140*	.030	.018	.104	.043
	.054	.077	.000	.000	.432	.654	.012	.259
	-.003	-.085*	-.208*	.232*	.011	.102*	.095*	-.073
	.933	.028	.000	.000	.766	.011	.022	.058
	.036	-.024	-.042	.138	.026	-.099*	.024	-.035
	.350	.533	.271	.000	.505	.013	.569	.358
	-.028	.085*	-.041	.023	.027	.044	.046	.028
Trademark-related Controls								
1. Timing of TM application (7 phases)	.472	.027	.281	.554	.489	.271	.268	.460
2. Combination with patent (s)	.016	.066	.062	-.081*	-.088*	.057	-.373**	.203*
3. Product innovation	.681	.087	.106	.035	.021	.156	.000	.000
4. Service innovation	.106**	.035	-.014	-.022	-.066	.051	-.144**	.166**
5. New-to-the-world innovation	.006	.363	.722	.563	.085	.206	.000	.000

(continued on next page)

Table 3 (continued)

	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
Dependent												
Patent												
Innovation mode												
Mode												
Controls												
	-.017											
	.662	-.177*										
	.075	.000										
	.050	.137**	-.087*									
	.000	.009	.023									
	.092	-.102*	-.089									
	.017	.008	.021	-.050								
	-.070	-.170*	-.147*	-.084*	-.085*							
	.071	.000	.000	.029	.027							
	-.049	-.130*	-.113*	-.064	-.065	-.109*						
	.206	.001	.003	.095	.090	.005						
	-.064	-.142*	-.123*	-.070	-.071	-.118*						
	.099	.000	.001	.068	.064	.002	-.091*					
	-.063	-.154*	-.133*	-.076*	-.077*	-.128*	-.098*					
	.103	.000	.001	.049	.046	.001	.018	-.107*				
	-.083	-.096*	-.083*	-.047	-.048	-.080*	.011	.005	-.072			
	.030	.013	.031	.221	.213	.038	.113	.083	.062			
	.047	-.004	-.140*	.050	.016	-.031	-.043	.118*	-.002	.008		
	.223	.924	.000	.192	.681	.427	.261	.002	.952	.829		
	.270**	.025	.048	.009	.057	-.083*	.002	-.031	-.060	-.053	.020	
	.000	.523	.215	.809	.141	.031	.954	.423	.119	.165	.610	
	.125**	.034	.046	-.072	.007	-.077*	.028	-.073	-.012	-.046	.074	.150**
	.001	.372	.237	.062	.850	.045	.473	.057	.758	.234	.054	.000

* . Correlation is significant at the .05 level (2-tailed).

** . Correlation is significant at the .01 level (2-tailed).

Table 4
Regression results.

Ordinal regression		Model 1			Model 2			Model 3		
Variables		B	std.err.	Sig.	B	std.err.	Sig.	B	std.err.	Sig.
Dependent	Timing of TM application (reference = commercial phase)									
	Idea	−2.174***	.232	.000	−2.531***	.292	.000	−2.797***	.369	.000
	Research	−1.645***	.221	.000	−1.996***	.283	.000	−2.253***	.360	.000
	Development	−.455**	.210	.030	−.790***	.273	.004	−1.020***	.349	.003
	Test	−.159	.210	.448	−.490*	.272	.072	−.728*	.348	.036
	Marketing	.750***	.212	.000	.438	.272	.107	.268	.347	.439
	Introduction	1.835***	.225	.000	1.543***	.281	.000	1.367***	.354	.000
Patents	Combination with patents	−.556***	.186	.003	−.379*	.199	.057	−.310	.213	.145
Innovation mode										
Length of development cycle	Product innovation				−.520***	.157	.001	−.549***	.170	.001
	Service innovation				−.326*	.171	.057	−.226	.189	.232
	New-to-the-world innov.				−.413*	.218	.058	−.287	.230	.213
	B2B				.125	.166	.451	.058	.176	.743
Start-up	Start-up							−.545***	.185	.003
Controls										
Firm size	Medium firm	.422**	.168	.012	.399**	.171	.019	.208	.197	.291
	Large firm	.578*	.229	.011	.540*	.232	.020	.190	.274	.487
Firm sector	SD (supplier-dominated manuf.)	−.217	.236	.357	−.130	.244	.596	.088	.303	.772
	SI (scale-intensive manuf.)	.233	.253	.358	.294	.259	.256	.586*	.319	.066
	SS (specialized suppliers)	.484	.366	.186	.548	.368	.137	.701*	.423	.097
	SB (science-based manuf.)	−.034	.351	.923	.069	.357	.847	.357	.401	.373
	SDS (supplier-dominated services)	−.465*	.260	.074	−.499*	.263	.058	−.286	.324	.377
	PN (physical networks)	.412	.299	.168	.329	.303	.277	.592	.361	.101
	IN (information networks)	−.461	.285	.106	−.484*	.288	.093	−.167	.348	.631
	KIBS (knowledge int. business services)	.037	.272	.891	.020	.277	.942	.269	.339	.427
	Non market services	.414	.372	.266	.556	.379	.142	.880**	.432	.042
Trademark-related controls	TM reference to both goods + services	−.076	.145	.599	−.108	.146	.458	−.090	.157	.566
	Previous TM experience	−.212	.150	.156	−.230	.150	.126	−.373**	.167	.026
	Use of IP agency	.312*	.169	.066	.301*	.170	.077	.361*	.187	.053
	N			.677			.677			.585
	Nagelkerke R square			.064			.087			.108
	Goodness of Fit (Pearson significance)			.758			.600			.484
	Chi-square (df)			43.4 (15)			60.4 (19)			64.8 (20)

* : Significant at the .1 level.

** : Significant at the .05 level.

*** : Significant at the .01 level.

development stage. We therefore included a control dummy in our regression analysis, controlling for trademarks with Nice classes referring to both goods and services. One explanation might be that these trademarks refer to all of the firm's activities and, therefore, mark the start of a firm. A closer look at our data reveals that 32% of the start-ups and future start-ups in our sample declared that the trademark filing referred to all products and/or services of the company. For the mature firms, this was only 13%.

5.1.2. Sectoral patterns

Our survey also provides us with sector information at NACE 2-digit level, which makes it possible to discriminate between low-tech sectors and high-tech sectors. Fig. 4 shows the breakdown of early and late trademark application for the sectors in our sample, according to the innovation-based taxonomy used in Castaldi (2009).

The share of firms with trademark applications in either the marketing, introduction or commercialization stages is higher for specialized suppliers (SS) and for firms in the scale-intensive (SI) and research-based (RB) sectors, compared to low-tech sectors in manufacturing, such as the firms in the supplier-dominated (SD) sector in our sample and most services sectors, but excluding firms belonging to the non-market services group, where the share of late trademark applicants is also high. To control for sectoral heterogeneity that was not already accounted for by the variables capturing innovation mode, we included four dummies for the manufacturing industries and five dummies representing the services sectors as control variables. Three

sectors – scale-intensive firms in manufacturing (SI), specialized suppliers (SS) and non-market oriented services firms – showed a significant tendency towards late trademark application.

5.1.3. Correlation results

The correlations among our independent variables are presented in Table 3. Some correlations are clearly evident. For example, patent protection is linked to product innovation but not to service innovation, which explains the large negative correlation between the combined use of patents and trademarks and service innovation dummies. There is also a significant positive correlation between start-up and service innovation, and a significant negative correlation between start-up and large firm size, indicating that most start-ups are small firms in the service sector. There is a significant positive correlation between the timing of trademark application and the dummies representing firm size. Medium-sized and large firms tend to file trademarks during the marketing stage of the innovation process. For the large firms in our sample, this figure is particularly high, at about 40%.

5.2. Regression analysis

Ordinal regression was used to examine the effect of our variables of theoretical interest on the dependent variables reflecting timing. Model estimations are presented in Table 4 for different model specifications. The estimated coefficients represent the log odds of later trademark application in the innovation process.

Innovation mode characteristics, such as product innovation and the applicant being a start-up, show significant negative coefficients, indicating a significant tendency towards early trademark application. The variable reflecting trademarks combined with patents (19% of the cases in our final sample) shows no significant tendency to early application in the innovation process, although more than 30% of the trademarks combined with patents in our sample were applied for during the development stage of the innovation process.

With respect to the determinants used to indicate differences between innovation development cycles, there is a tendency towards early trademark application in the case of determinants which indicate long development cycles. The estimated coefficient for the product innovation dummy (which is associated with long development cycles) is negative and significant, while it is not significant for service innovation. Thus, the evidence indicates that trademarks referring to product innovation are filed earlier than those referring to all other forms of innovation, including service innovation. However, this does not hold for innovation which is new to the world or with reference to B2B products or services, both of which are associated with long development cycles. Start-ups (which made up approximately 50% of our sample) show the most significant tendency towards early trademark application.

5.3. Robustness checks

We checked the robustness of our models by combining different stages and thus reducing the number of categories of our dependent variable to four stages (idea + research stage, development + test stage, marketing stage, introduction + commercialization stage) and also to two stages (up to the test stage and marketing stage or later). Both robustness checks did not influence any of the findings presented in Section 5.2. The results for the controls, however, showed some differences. Large firm size is very significant in the robustness check in which late trademark application is defined as during the marketing stage or later. The basic statistics reveal that a majority of the large firms in our sample applied for trademarks during the marketing stage of the innovation process. The same also holds for the control dummy representing the use of an IPR agency. Most firms using the services of an IPR agency to file their trademark application did this during the marketing stage of the innovation process. Firms with previous trademark experience, however, show a tendency towards early trademark application, although the effect is slightly less strong. The robustness check for the most elaborate model confirmed the tendency towards earlier trademark application in the case of previous experience.

6. Discussion

6.1. Implications for theory

Because of their nature and relatively short handling times at IPR offices, the majority of the literature assumes that trademarks are registered close to the market introduction of a new product or service and therefore are an indicator of late-stage innovation. Others have argued that early trademark application occurs. Our findings show that the predominant assumption that filing occurs late is not supported by the data. However, we did not find that the opposite was the case. Rather, the timing of filing appears to depend on various firm and innovation mode characteristics. We therefore argue that further theoretical exploration of the determinants of early and late filing is required, including the question of how organizations balance the various reasons for filing late or early. There are various avenues for further research that can be pursued in this respect.

First, consideration of the various motives for trademark application in the analysis may further clarify why some of our findings diverge from some of the predictions. Research by Block et al. (2015) showed that trademark applicants may have three distinct motives: protection,

marketing and exchange. The strength of these motives may have an impact on the timing of a trademark application.

Second, our data cannot fully capture the appropriability regime of the innovation for which the trademark is applied. We applied Castaldi's taxonomy (2009) as a proxy for appropriability regimes. This proxy, however, is imperfect as it assumes sectoral homogeneity concerning the appropriability regime. There are also other factors which influence appropriability conditions (Hurmelinna-Laukkanen and Puumalainen, 2007). Additional research which takes intra-sector heterogeneity into account is therefore needed to enhance our understanding of the relationship between the appropriability regime and the timing of trademark applications.

Third, one limitation of our study is that information about the underlying innovation processes was limited. A direct measure of both the total length of the innovation process and the length of different phases within the process may provide a more definitive answer to the question of how differences between innovation processes influence the timing of trademark applications. One reason for the inconclusive results of our regression analysis on service innovation may be that our survey used Cooper's new product development (NPD) process for the cases involving service innovation. A more general innovation model which accounts for different types of innovation and also accounts for less linear innovation processes, which often occur in relation to service innovation (Alam and Perry, 2002), may improve results.

6.2. Implications for practice

Our results suggest that practitioners should think carefully about when to apply for trademarks. To determine the right time, they could at least take their firm type and innovation mode into consideration. A standardized policy for all trademark applications made by all companies does not match with the practices that we observed.

A second observation relevant to practitioners is that, in general, we found a tendency towards earlier trademark application by firms with previous trademark experience. This implies that from their previous experiences, these firms have become more aware of the necessity of timely trademark application. This may indicate that inexperienced firms apply for trademarks too late. These firms may find that advice from an expert or from an experienced company can help them to avoid the potential pitfalls of late trademark application.

6.3. Implications for policy

Our study supports the usefulness of trademarks as an innovation indicator, as proposed by Mendonça et al. (2004) and Flikkema et al. (2014). However, policymakers must take into account that trademarks can refer to early stage invention as well as later stage innovation. Early trademark application is especially relevant in cases of product innovation and innovation by start-ups. The use of trademark statistics for the development and evaluation of innovation policies can take this finding into account. Literature on the motives for trademark application shows that an important reason why start-ups file trademarks is to signal technological and marketing capabilities and thereby attract venture capital (Zhou et al., 2016). Block et al. (2014) and Zhou et al. (2016) found that trademarks indeed increase venture capital funding. Entrepreneurship policy should therefore promote the development of these capabilities, including an effective trademark filing strategy by early phase innovating start-ups.

7. Conclusions

This is the first empirical study to look at the timing of trademark applications in innovation processes across various industries. Our paper contributes to the innovation literature by testing competing predictions about early versus late application for trademarks. It expands on previous studies into the usefulness of trademarks for

measuring innovation (Mendonça et al., 2004; Flikkema et al., 2014) and shows that the relationship between the timing of trademark applications and their combination with patents, as well as the relationship between timing and the applicant's innovation mode are more nuanced than the literature suggests.

Concerning the relationship between the combination of patents and trademarks and the timing of trademark application, our simplest model showed that there is a tendency towards early trademark application in the case of combination with patents. However, our regression analysis showed that this effect disappeared when we take into account the newness of an innovation, which is also a prerequisite for patentability, and for the firm being a start-up. Trademarks are filed later in the innovation process even when they are combined with patents. Moreover, established firms, with incremental innovation, especially showed a tendency towards late trademark application, whether in combination with patents or not.

Concerning the relationship between the applicant's innovation mode and the timing of trademark application, we can draw three conclusions. First, trademarks for service innovation are not primarily applied for in the late stages of the innovation process. Firms apply for trademarks for service innovations in all stages of the innovation process. One possible explanation for this might be that service innovation may follow different innovation patterns (Den Hertog, 2000), also depending on the locus of innovation. In particular, service innovation does not always happen 'on the job' within client firms, but might be the outcome of dedicated activities that some service firms develop as internal capabilities (Janssen et al., 2015). Future research that includes the study of more characteristics of the innovation process might aim to determine whether the locus of service innovation predicts the timing of trademark applications.

Second, there is a tendency towards late trademark application by firms in high-tech manufacturing industries, such as scale-intensive manufacturers and specialized suppliers. The development of innovations in these sectors tend to have long cycles (Griffin, 2002). One possible explanation for this might be that the cycles in these sectors approximate or exceed the period defined by the use in commerce requirement in trademark law, forcing them to postpone their trademark application. Late trademark application also holds for non-market services, which can be explained by the non-commercial nature of these firms, typically associated with a disregard for commercial interests.

Third, start-ups show a strong tendency towards early trademark application, especially when the trademark refers to product innovation. This indicates that the assumptions made in the literature on brand management (Klink, 2003) and on the use of trademarks as an innovation indicator (Hipp and Grupp, 2005) – that trademarks are applied for during the later stages of the innovation process and therefore refer to later stage innovation – hold for established firms but not for start-ups. In the case of established firms, trademarks may therefore be a powerful indicator of innovations that make it to the market. This result confirms recent findings in trademark research that start-ups tend to file initial IPRs in the form of trademarks (De Vries et al., 2017), especially when the start-up is backed by venture capital.

One final intriguing finding relates to trademark law. Counter to the expectations of some studies and also counter to the second finding concerning late trademark application in some high-tech sectors, the use in commerce requirement does not seem to lead to later applications on a large scale. Our data, which included trademark applications from sectors with long development cycles, suggest that the priority principle overrides the use in commerce requirement and leads organizations to apply for trademarks in earlier phases. Whether the use in commerce requirement is effective in preventing premature trademark applications may therefore be questioned.

Our general conclusion is that care should be taken when using trademark counts as indicators of late-stage innovation and of service innovation only, as some studies would suggest. We have shown here that trademarks may also indicate early stage innovation, particularly

for radical product innovation in start-ups.

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